SOLEX THERMAL SCIENCE

World leaders in the science of heating and cooling bulk solids.

TECHNICAL ARTICLE

Cooling Fertilizer Granules with the Solex Heat Exchanger

Prepared by:
Denis Piché, P. Eng.
Project Manager, Solex Thermal Science, Inc.
Calgary, Alberta, Canada

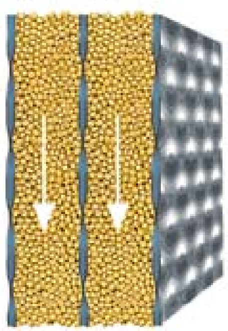
BACKGROUND

Ten years ago, the Solex Heat Exchanger was introduced to the fertilizer industry. It was a new piece of process equipment for cooling bulk solids and was ideally suited to cooling granular and prilled fertilizers. The Solex Heat Exchanger provided an alternative to the fluid bed and rotary coolers that had been up to that point the industry standard. With more than 40 Exchangers now in use in the fertilizer industry, this paper reviews the important considerations in designing Solex Heat Exchangers for fertilizer cooling.

DESCRIPTION OF TECHNOLOGY

The Solex Heat Exchanger uses plate heat exchanger technology for efficient, indirect cooling of fertilizer granules and prills. The heat exchanger consists of a series of vertical hollow stainless steel plates. Fertilizer granules move slowly by gravity between the plates in mass flow. Cooling water flows through the plates and is counter-current for improved efficiency. Below the Plate Bank is a discharge feeder that controls the flow of the product material through the heat exchanger.

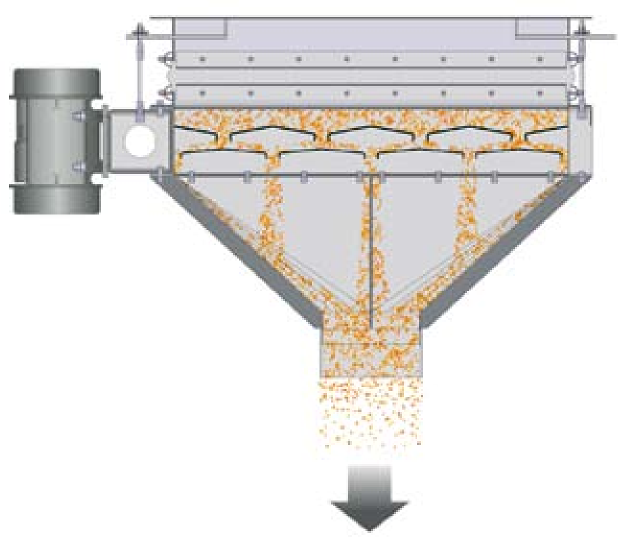
INDIRECT COOLING BY CONDUCTION



- Mass flow ensures even temperature
- No product degradation
- Efficient design - large heat transfer area in a compact unit
- Indirect cooling – no contact between cooling water and product
- No cooling air required – no emissions
- No fans, no scrubbers and no baghouses
- Designed to pressure vessel code

DISCHARGE FEEDER

Mass flow is created in the Solex Heat Exchanger with the Discharge Feeder. The Discharge Feeder also regulates the flow of solids through the Exchanger. For fertilizer applications, we typically use either a Vibrating Feeder or Gate Feeder.



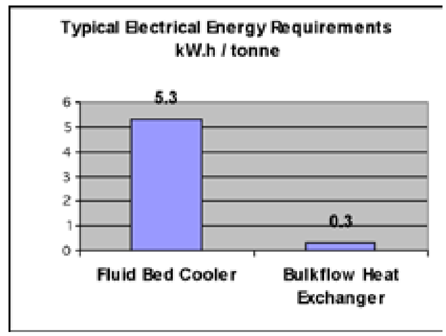
Vibrating Tray Feeder:

- Overlapping trays create mass flow over full cross section of heat exchanger
- Driven with two low horsepower vibrator motors
- Variable frequency drive controls flowrate
- Small amplitude 0.5 – 1.0 mm to prevent product degradation
- Product Shut-off at zero frequency

SOLEX HEAT EXCHANGER ADVANTAGES

The Solex Heat Exchanger offers a number of advantages compared to fluid bed or rotary coolers:

- No air emissions
- Low energy consumption
- Compact design
- Lower installed capital cost
- Simple system with few moving parts – easy installation and low maintenance costs
- Easy access for inspection and maintenance



PRODUCT TESTING

Cooling tests are conducted at the fertilizer plant to evaluate the Solex Heat Exchanger under normal process conditions. The test unit duplicates the design and operation of the full size equipment and is completely instrumented to collect heat transfer data. Test results are used to confirm the design and operation of the equipment.

Cooling Test for MAP Granules at Bunge Fertilizantes, Ponta Grossa, Parana, Brazil (2001)

FERTILIZER COOLING APPLICATIONS

Solex Heat Exchangers have been used to cool the full range of fertilizers:- urea granules and prills, ammonium nitrate and CAN, NPK's, MAP, DAP, TSP, ammonium sulphate.

The principles of operation are similar for each type of fertilizer, but certain details change to allow for the somewhat different properties.

UREA PRILLS

In the majority of urea prill plants, there is no separate cooling after the prill tower. In the original plant design, the prill tower was high enough and had sufficient air to cool the prills to an acceptable temperature for storage. The situation changes when the plant capacity is increased – a very common scenario today with many innovative technologies available for increasing urea plant outputs as provided by Stamicarbon and Urea Casale.

The increased capacity in the urea plant reaches a bottleneck at the prill tower, since the cooling capacity is in large part fixed by the height of the tower. A solution to the problem is the Solex Heat Exchanger, which provides additional product cooling after the prill tower and before storage.

The Solex Heat Exchanger is installed after the prill tower. The discharge elevation from the prill tower is low, typically by means of a rake and conveyor. Generally a bucket elevator will be required to feed the Exchanger. An important detail is to include a small vibrating oversize screen at the inlet to the cooler to prevent lumps entering the exchanger. Lumps occasionally form on the walls of the prill tower, rake, elevator casing etc.

Urea prills have less mechanical strength than granules, and this tends to create more dust in the product. High dust levels increase the risk of caking in the Exchanger, therefore a good ventilation system venting from the Inlet Hopper of the Exchanger is important to reduce the dust level and improve Exchanger performance.

NPK FERTILIZERS

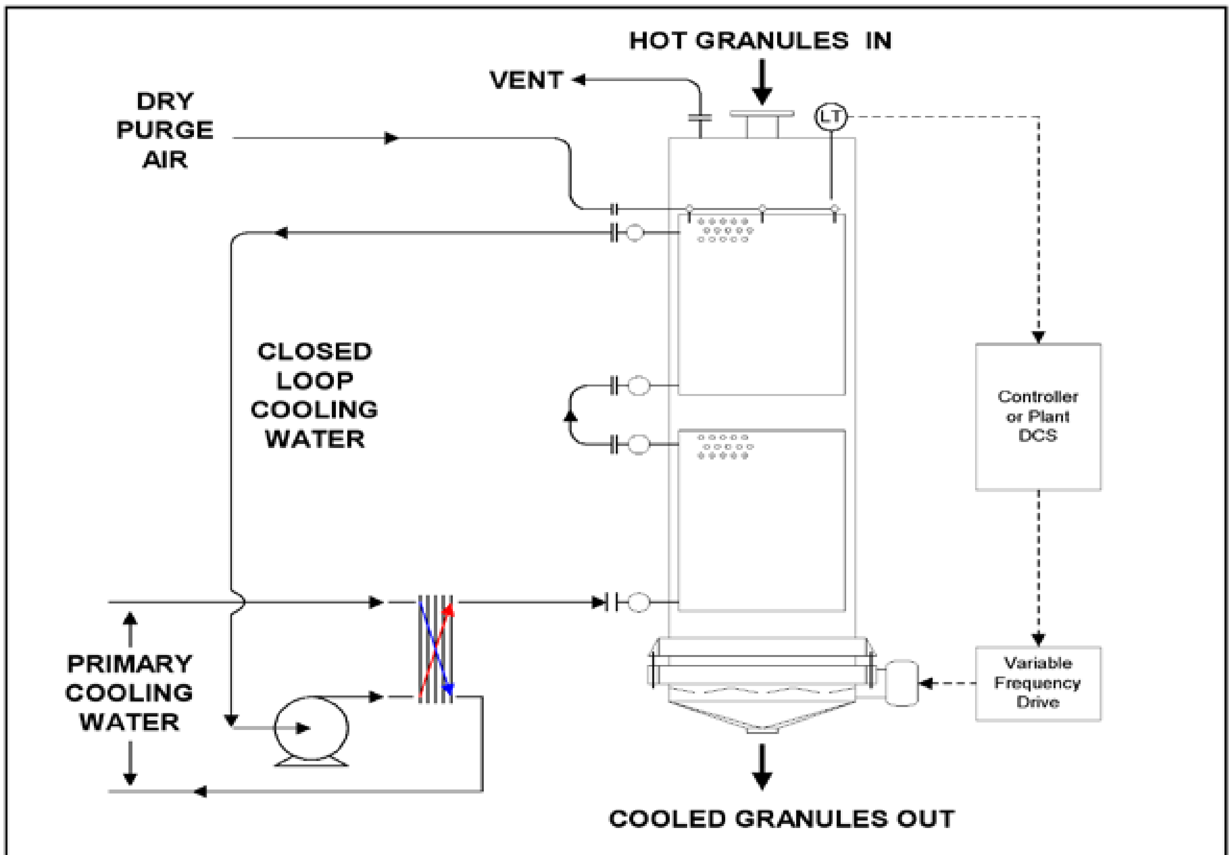
NPK plants normally produce a wide range of NP and NPK formulations. The process conditions such as flowrate and the thermal properties of the different compositions can vary. It is important to analyze the "worst case" conditions so that the Exchanger can be sized accordingly.

MAP, DAP & TSP

Phosphate fertilizer plants are inherently less stable than a nitrogen plant, because they have to deal with the variations in raw material feed. This variation in process conditions, coupled with higher moisture in phosphate fertilizers slightly increases the tendency for caking. This caking is common throughout the granulation section of a phosphate plant and the plants are routinely shutdown for cleaning. To allow for this, a more conservative design is used for the Exchanger, allowing a larger factor of safety in sizing the unit and an increased plate spacing. This means that

the Exchanger can operate with a certain level of caking and still meet the specified discharge temperatures, this way the equipment can follow the overall plant cleaning schedule. In addition since cleaning is a known requirement, good maintenance access is provided and the plant needs to arrange a convenient system for the wash water supply and disposal.

MAP Cooler at Fosfertil, Uberaba, Brazil (1994)



Typical Schematic for Granule Cooler with closed loop coolin gwater